Fall 2000 through Spring 2001

Wisconsin Department of Natural Resources
Bureau of Fisheries Management and Habitat Protection

Root River Steelhead Facility
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Abstract – A total of 7,375 chinook salmon, 3,408 coho salmon, 1,078 steelhead and 245 brown trout were examined at the Root River Steelhead Facility during fall, 2000 and spring, 2001. The majority of the chinook (6,965 or 94%) were passed upstream. The remaining 410 were sacrificed after spawning, for disease testing, or were too weak to pass. A total of 2,921 coho salmon were passed upstream, another 472 were transported to Kettle Moraine Springs Hatchery as broodstock, and the remaining 15 were sacrificed for disease testing, or were too weak to pass. One thousand nine coho salmon were spawned to produce 1.2 million eggs. The fall return of steelhead was again low, at only 219. One hundred sixty skamania-strain steelhead were identified by fin clips and transported along with five skamania from the Kewaunee River to Kettle Moraine Springs Hatchery as broodstock to produce 145,922 eggs. The remaining 59 were passed upstream. The bulk of the spring steelhead (790 fish) were passed upstream; 239 of these were spawned before passage, while another 63 were too weak to pass upstream after spawning. The 302 spawners produced 788,000 eggs. The remaining 6 spring steelhead were sacrificed for contaminants testing. All 245 brown trout and 4 brook trout were passed upstream. The estimated population of chinook salmon, at 38,575 ($\pm$ 9,685 SD), was nearly three times the estimate from 1999, the next-highest year. The estimated populations of coho salmon (10,091 $\pm$ 2,565 SD) and brown trout (5,302 $\pm$ 5,180 SD) were also at record levels. Estimated populations of chambers creek and ganaraska steelhead were 512 ($\pm$ 313 SD) and 2,137 ($\pm$ 769 SD), respectively. Fall steelhead were estimated at 157 ($\pm$ 51 SD).

Cover photo: Dennis Goulee with a 17-pound skamania-strain steelhead. Photo by the author.

The Root River Steelhead Facility (RRSF) is a valuable source of fish for both anglers and fishery managers. It is one of three weirs operated by Wisconsin Department of Natural Resources (WDNR) to collect information and broodstock from Lake Michigan trout and salmon. The Strawberry Creek Weir in Sturgeon Bay targets chinook salmon, while the Basadney Area Fishery Facility (BAFF) on the Kewaunee River targets coho salmon and the RRSF contributes primarily steelhead. In addition, BAFF and RRSF provide backup collection sites for the other species. Brown trout do not return well to the weir sites, and are collected in the lower reaches of the rivers with a boat electroshocker. Management of trout and salmon in Lake Michigan brood rivers is intended to ensure adequate egg collections, conserve the genetic diversity of feral trout and salmon stocks and provide fishing opportunities. To accomplish these objectives, weir operations follow strategies outlined by WDNR guiding documents (e.g., Ives 1996, WDNR 1999).

The weirs provide a more efficient and reliable method to collect adult salmonids than the portable weirs and electrofishing efforts employed during past years. The RRSF was constructed in 1994 through a cooperative effort by WDNR, Salmon Unlimited, City of Racine and U.S. Fish & Wildlife Service. In addition to providing a collection and processing site for returning adult salmonids, the RRSF provides a unique educational tool for school groups and other interested publics.

This paper reports the results of data collected at the RRSF during fall, 2000 through spring, 2001. These data contribute to a long-term index of chinook, coho and steelhead populations in the Root River, and are collected to fulfill three objectives: 1) track the abundance of salmonid returns, 2) measure growth and condition of each species and/or strain, and 3) estimate return rate of each species.

METHODS

During operation of the weir, a minimum of 100 fish per targeted species and fin clip were sampled, except that no skamania steelhead were sampled during fall, 2000 in an effort to reduce mortality of broodstock. Sampled fish were measured to the nearest millimeter, weighed to the nearest 0.1 pound, examined for fin clips, gender and condition. The remaining fish were tallied by species, gender and fin clip. Gametes were stripped from these fish, if needed. After this initial handling, fish were either held for broodstock, passed upstream or sacrificed (fish health or contaminant samples). All fish passed upstream were given an upper caudal clip for population estimates.

All non-target species or fin clips were tallied by species, fin clip and sex, given an upper caudal clip and passed upstream. All coded wire tagged (CWT) fish are marked by an adipose-only clip, and have a tiny microtag implanted in their heads. The CWT fish were measured, weighed and sacrificed; heads were removed from behind the opercular flap, and frozen for later examination. Fish needed for other studies including disease or contaminant samples were frozen for later examination.

Size and condition

Trends in size and condition of all species processed at RRSF are calculated. Only fish with both total length and weight data are included in calculations of 1) average weight, 2) trophy weight (95^{th} percentile of the weight distribution), and 3) standard weight (predicted weight at a given length based on a length-weight regression).

Steelhead strain evaluation

Approximately 33,000 fish per steelhead strain (skamania, chambers creek and ganaraska) are stocked into the Root River annually. All steelhead stocked in the broodstock rivers (Root and Kewaunee Rivers) are marked with a fin clip to identify the strain and yearclass. Each strain is assigned three fin clips (two fin clips prior to 1997), which are rotated annually. In addition to their use in identifying fish for breeding purposes, the fin clips allow each strain to be evaluated. This includes age of returning fish, return rates and population estimates by strain.

Population estimates

Fish that are passed by the weir are marked with a caudal (tail) clip, and recaptures of marked fish are noted in the creel survey for a mark-recapture population estimate of the population above the weir. Population

estimates for each species or strain are derived from one of two equations. When sample sizes were adequate, the Petersen equation for mark and recapture was used (Ricker 1975):

$$N = \frac{M * C}{R} \quad (1)$$

Where

N = size of population in the river
M = number of marked fish at large in the river
C = number of recaptured fish
R = number of marked fish in the recapture sample

The sample standard deviation was calculated as:

$$S(N) = \sqrt{\frac{M^2 * C * (C - R)}{R^3}} \quad (2)$$

For species or strains with low sample sizes, the Bailey's modified equation was used for the population estimate (Ricker 1975):

$$N = \frac{M * (C + 1)}{R + 1} \quad (3)$$

With sample standard deviation:

$$S(N) = \sqrt{\frac{M^2 * (C + 1) * (C - R)}{(R + 1)^2 * (R + 2)}} \quad (4)$$

RESULTS AND DISCUSSION

The sixth season of operation for RRSF began July 24, 2000 and concluded April 23, 2001. A total of 7,375 chinook, 3,408 coho, 1,078 steelhead and 245 brown trout were examined (Table 1).

Chinook salmon

A total of 7,375 chinook salmon were examined at RRSF during fall, 2000 (Table 2). A number of chinook were sacrificed for disease testing (166), after spawning (101) or died in the weir (143). The spawned fish were part of a fish-health survey; eggs for hatchery production were taken at Strawberry Creek near Sturgeon Bay (see Peeters and Royseck 2000). The majority (6,965 or 94%) were passed upstream.

Average weight of chinook salmon was 12.3 pounds, a pound below the 1999 value, but still above the seven-year average of 11.9 pounds (Table 3). Average length, standard weight and trophy weight were nearly identical to the mean values.

Coho salmon

During September 18 through November 6, 2000, 3,408 coho salmon were examined at RRSF (Table 4). Most coho (2,921) were passed upstream, constituting 86% of the return. Another 15 were saved for contaminants analysis, 231 were transferred to a hatchery for spawning and 241 died in the weir or were too weak to pass upstream. About 1.2 million eggs were taken from 1,045 coho at the weir. Age composition (based on length-frequencies) was skewed towards older fish, with only 7% age 1+ and 93% age 2+ (Table 5).

For the second consecutive year, average weight and length were the highest recorded for coho salmon at RRSF (Table 3), perhaps partly due to the large percentage of 2-year-old fish (Table 5). Standard weight and trophy weight were second only to 1999, indicating that the coho were quite healthy.

Steelhead

Summer weir operations targeting skamania-strain steelhead were increased to offset declining returns in recent years, but spring operations were delayed due to flooding. Returns of ganaraskas were adequate, but few chambers creek steelhead were captured, possibly due in part to the late start of weir operations. A total of 1,078 steelhead were examined at RRSF from July 24, 2000 to April 23, 2001. Most fish (849 or 79%) were passed upstream (Table 6). Six steelhead were sacrificed for disease testing or contaminants samples and 63 were too weak to pass after spawning. One hundred sixty skamania-strain steelhead were transported to Kettle Moraine Springs hatchery (KMSH) during late summer and fall, along with five fish from BAFF. Transport stress, furunculosis and a few non-spawners reduced the number of skamania spawners to 78.

Egg collections totaled 145,922 skamania, 215,000 chambers creek and 573,000 ganaraska. Combined steelhead-broodstock numbers from the BAFF (Hogler and Surendonk 2001) and RRSF have declined below the target of 200 to 250 pairs per strain (Ives 1996), and the spring, 2001 return was primarily small, age-3 fish. Egg collections, which should total 500,000 per strain to produce 170,000 yearling steelhead, were inadequate as a result. Egg collections and post-hatch survival were particularly poor for skamania. In August, 2001, an estimated 50,000 to 60,000 yearling skamania were projected for stocking in spring, 2002.

During most years, age 3 and 4 fish contribute the bulk of the steelhead run. Comparing among yearclasses with data through age 4, fall return-rates were only around 0.35% for the 1995 and 1996 yearclasses, compared to 0.75% to 2.55% for 1991 through 1994 (Table 7). The spring returns have been stronger, but the spring return-rate of the 1997 yearclass (which returned at age 4 during 2001) was over 50% lower than the next lowest yearclass (Table 7). It appears that the 1997 yearclass of chambers creek and ganaraska strains experienced high post-stocking mortality, a subject that deserves additional attention. It will not be clear if the fall return (mostly skamania) experienced a similar decline until after the age-4 fish return during fall, 2001, but it is on track to a mediocre performance similar to the 1995 and 1996 yearclasses.

Management actions to address the decline in steelhead broodstock were recommended by the WDNR Lake Michigan Fisheries Team during July 2001. Their recommendations include increased weir operations, collection of additional broodstock by electroshocking, fin clipping of all steelhead, inoculation of adult skamania against disease, addition of skamania gametes from other sources to increase genetic diversity, and investigating additional steelhead strains. A reduction in angler bag limits either below the weirs or in all Wisconsin waters of Lake Michigan is under consideration. A steelhead research agenda is under development. If broodstock collections continue to decline, then we will eventually have to consider replacing one or more of the current strains with a new strain of steelhead.

Steelhead strain evaluation

The percent age composition of the runs was assigned from age-length keys developed from 75 fall skamania and 392 known-age (fin clipped) spring fish. During fall, only fish that died after transport to KMSH were weighed and measured. This sample may be biased if some sizes or ages were more prone to mortality. The data were used to estimate age composition (Table 8) and for average skamania length and weight at age (Table 9) but were excluded from season-wide averages (Table 3). Age 2 represented 2.7% of the fall sample, 3 were 25.3%, 4 were 46.7%, 5 were 6.7%, 6 were 8.0% and 7 were 10.7%. During spring, age 2 represented 3.5% of the return, 3 were 83.2%, 4 were 8.9%, 5 were 1.4%, 6 were 2.8% and 7 were 0.2% (Table 8). Steelhead returns during spring, 2001 were skewed towards age 3 fish, while the 2000 returns were skewed towards age 4, compared to a fairly balanced contribution by age 3 and 4 during most previous springs. This again highlights the poor performance of the 1997 yearclass of chambers creek and ganaraska.

All three steelhead strains have been stocked in approximately equal proportions over the last decade (Appendix A). Each strain receives a unique fin clip, and fin clips within a strain are rotated on a three-year cycle since 1997. This allows much cleaner separation of yearclasses than the two-year fin clip rotation used previously. Fall skamania of all age groups except age 5 had higher average length and weight than spring steelhead of the same age, but were comparable to spring fish one year older (Table 9, Table 10). This is probably because a given-age fish in fall will be classified one year older the following spring, but puts on little growth during the winter months. Skamania with a right maxillary/right ventral fin clip were only stocked during 1997, so all fish with this clip were age 4. These age-4 fish ranged from 26.9

inches and 5.75 pounds to 36.4 inches and 15 pounds, showing much variability in size at age. Age-3 fish of all three strains were similar in length and nearly identical in length during spring, 2001 (Table 10). Other spring ages varied in length.

Population estimates

All fish passed upstream of RRSF received a caudal clip for use in a mark-recapture population estimate of trout and salmon in river-reaches upstream of the weir (Table 11). The recapture phase of the estimate uses the creel survey to identify upstream recaptures. A record 38,575 (± 9,685 SD) chinook salmon were estimated during 2000, almost three times the previous record return during 1998. The coho estimate of 10,091 (± 2,565) is also a record. The run was 93% age-2 fish, following very low returns during 1999. Although only 20 of 59 steelhead marked and passed upstream in the fall were identified as skamania, they comprised 82% of the fall steelhead encountered at the weir (the remaining 160 skamania were transported to the hatchery). If 82% of the fall steelhead population (estimated at 157 ± 51 SD) is combined with the hatchery removals, then about 289 skamania returned during fall, 2000. Chambers creek were estimated at 512 (± 313 SD), while the ganaraska estimate was 2,137 (± 769 SD). These estimates are lower than optimal, but they are the highest since 1997. The population estimates highlight the fact that the weir is not designed to capture every returning fish, and only around 1/3 of returning steelhead are handled at RRSF.

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Table 1. Summary of chinook salmon, coho salmon, steelhead, brown and brook trout captured at the Root River Steelhead Facility during 1994-2001.

CHINOOK SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	129	1,726	3	1,858
Fall, 1995	300	2,663	16	2,979
Fall, 1996	62	5,440	87	5,589
Fall, 1997	0	3,974	128	4,102
Fall, 1998	67	3,845	65	3,977
Fall, 1999	221	5,381	420	6,022
Spring, 2000	0	7	0	7
Fall, 2000	244	6,965	166	7,375

COHO SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	285	513	15	813
Fall, 1995	1,191	2,115	15	3,321
Fall, 1996	161	3,940	305	4,406
Fall, 1997	655	6,909	330	7,894
Fall, 1998	328	3,336	336	4,000
Fall, 1999	154	978	18	1,150
Fall, 2000	472	2,921	15	3,408

STEELHEAD

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	218	583	47	848
Spring, 1995	120	2,582	18	2,720
Fall, 1995	330	208	0	538
Spring, 1996	150	2,970	49	3,169
Fall, 1996	248	105	0	353
Spring, 1997	2	2,918	125	3,045
Fall, 1997	408	228	8	644
Spring, 1998	0	382	0	382
Fall, 1998	86	64	1	151
Spring, 1999	0	2,131	132	2,263
Fall, 1999	50	19	1	70
Spring, 2000	0	2,107	64	2,171
Fall, 2000	160	59	0	219
Spring, 2001	63	790	6	859

BROWN TROUT

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	0	259	0	259
Fall, 1995	46	645	0	691
Spring, 1996	0	4	0	4
Fall, 1996	70	244	0	314
Spring, 1997	0	2	0	2
Fall, 1997	114	369	3	486
Spring, 1998	0	2	0	2
Fall, 1998	14	202	12	228
Fall, 1999	0	125	0	125
Spring, 2000	0	6	0	6
Fall, 2000	2	241	0	243
Spring, 2001	0	2	0	2

BROOK TROUT

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	0	160	0	160
Spring, 1995	0	1	0	1
Fall, 1995	0	6	0	6
Fall, 1996	0	5	0	5
Fall, 1997	0	2	0	2
Fall, 1998	0	1	0	1
Fall, 1999	0	6	0	6
Fall, 2000	0	4	0	4

Table 2. Number of chinook salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2000.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
24-Jul-00	0	0	0	0
28-Jul-00	0	0	0	0
02-Aug-00	0	0	0	0
08-Aug-00	0	0	0	0
11-Sep-00	5	156	0	161
13-Sep-00	1	210	0	211
18-Sep-00	0	107	0	107
21-Sep-00	36	540	0	576
25-Sep-00	1	145	0	146
28-Sep-00	0	145	0	145
02-Oct-00	6	296	103	405
04-Oct-00	6	318	61	385
05-Oct-00	0	586	0	586
06-Oct-00	106	583	2	691
09-Oct-00	10	713	0	723
12-Oct-00	9	622	0	631
16-Oct-00	17	1,002	0	1,019
19-Oct-00	6	474	0	480
23-Oct-00	4	5	0	9
24-Oct-00	17	320	0	337
26-Oct-00	15	277	0	292
30-Oct-00	0	231	0	231
02-Nov-00	4	155	0	159
06-Nov-00	1	80	0	81
Totals	244	6,965	166	7,375

Table 3. Average weight, average length, standard weight and trophy (95th percentile) weight for the major salmonid species returning to the Root River Steelhead Facility during 1994 to 2001.

Season	Number used in analysis	Average weight (pounds)	Average length (inches)	Standard weight	Trophy weight
CHINOOK SALMON					
1994 – 95	343	8.9 ± 5.3	27.7 ± 5.6	9.7	17.8
1995 – 96	443	12.0 ± 5.9	30.7 ± 5.2	10.1	21.0
1996 – 97	703	11.7 ± 5.7	30.7 ± 5.4	9.8	21.1
1997 – 98	490	12.7 ± 4.9	32.5 ± 4.4	9.5	21.1
1998 – 99	389	12.2 ± 5.0	31.9 ± 4.3	9.5	19.6
1999 – 2000	418	13.2 ± 4.4	32.5 ± 3.8	9.9	19.9
2000 – 01	536	12.3 ± 5.7	31.1 ± 5.7	9.7	20.0
COHO SALMON					
1994 – 95	208	1.5 ± 1.1	15.9 ± 2.5	3.7	3.0
1995 – 96	594	3.1 ± 2.5	19.6 ± 5.1	3.6	9.0
1996 – 97	1,273	5.1 ± 2.4	23.9 ± 4.7	3.5	8.3
1997 – 98	828	3.8 ± 1.7	21.8 ± 3.5	3.5	6.7
1998 – 99	477	4.3 ± 1.7	23.4 ± 3.1	3.4	7.5
1999 – 2000	338	7.1 ± 4.4	25.5 ± 5.9	4.0	13.5
2000 – 01	472	8.2 ± 2.5	27.3 ± 3.2	3.9	11.6
STEELHEAD					
1994 – 95	638	5.9 ± 2.8	25.4 ± 4.7	3.5	10.7
1995 – 96	963	6.2 ± 2.7	25.6 ± 4.3	3.7	11.0
1996 – 97	626	7.2 ± 2.4	27.4 ± 3.3	3.6	11.2
1997 – 98	522	5.8 ± 2.9	25.7 ± 4.9	3.4	11.2
1998 – 99	603	6.2 ± 2.0	25.9 ± 3.3	3.9	9.8
1999 – 2000	766	7.3 ± 2.5	27.2 ± 3.9	3.6	11.0
2000 – 01	482	5.0 ± 1.7	24.1 ± 2.7	3.7	8.4
BROWN TROUT					
1994 – 95	108	4.9 ± 1.5	22.1 ± 2.7	3.4	7.0
1995 – 96	201	5.3 ± 2.2	22.4 ± 3.3	3.6	9.0
1996 – 97	162	4.6 ± 2.1	21.4 ± 4.0	3.4	7.8
1997 – 98	250	6.7 ± 3.4	24.0 ± 3.7	3.8	14.1
1998 – 99	55	6.6 ± 3.2	24.3 ± 3.5	3.5	13.5
1999 – 2000	120	6.7 ± 2.6	23.9 ± 3.7	3.5	10.1
2000 – 01	No data				

Table 4. Number of coho salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2000.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
24-Jul-00	0	0	0	0
28-Jul-00	0	0	0	0
02-Aug-00	0	0	0	0
08-Aug-00	0	0	0	0
11-Sep-00	0	0	0	0
13-Sep-00	0	0	0	0
18-Sep-00	0	91	0	91
21-Sep-00	3	404	15	422
25-Sep-00	1	61	0	62
28-Sep-00	0	22	0	22
02-Oct-00	1	81	0	82
04-Oct-00	119	79	0	198
05-Oct-00	0	80	0	80
06-Oct-00	2	172	0	174
09-Oct-00	2	211	0	213
12-Oct-00	113	34	0	147
16-Oct-00	1	133	0	134
19-Oct-00	13	102	0	115
23-Oct-00	38	338	0	376
24-Oct-00	26	183	0	209
26-Oct-00	56	461	0	517
30-Oct-00	76	153	0	229
02-Nov-00	21	266	0	287
06-Nov-00	0	50	0	50
Totals	472	2,921	15	3,408

Table 5. Estimated age composition of coho salmon (sexes combined) examined at the Root River Steelhead Facility during fall, 1994 - 2000. Age is based on age-length key developed from known aged fin clipped coho salmon, except during 1999 and 2000, when ages were assigned by length-frequency of measured fish. Total number represents the number of coho salmon used in the analysis.

Year of Return	Percent age composition 1+	2+	Total Number
1994	53	47	780
1995	24	76	3,049
1996	32	68	4,211
1997	5	95	7,699
1998	12	88	4,170
1999	44	56	341
2000	7	93	472

Table 6. Number of steelhead harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2000 and spring, 2001.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
24-Jul-2000	52	0	0	52
28-Jul-2000	49	0	0	49
02-Aug-2000	33	0	0	33
08-Aug-2000	20	0	0	20
11-Sep-2000	4	1	0	5
13-Sep-2000	0	0	0	0
18-Sep-2000	0	0	0	0
21-Sep-2000	0	4	0	4
25-Sep-2000	0	7	0	7
28-Sep-2000	0	0	0	0
02-Oct-2000	0	0	0	0
04-Oct-2000	0	1	0	1
05-Oct-2000	0	0	0	0
06-Oct-2000	0	0	0	0
09-Oct-2000	0	3	0	3
12-Oct-2000	2	0	0	2
16-Oct-2000	0	3	0	3
19-Oct-2000	0	0	0	0
23-Oct-2000	0	0	0	0
24-Oct-2000	0	5	0	5
26-Oct-2000	0	11	0	11
30-Oct-2000	0	7	0	7
02-Nov-2000	0	11	0	11
06-Nov-2000	0	6	0	6
29-Mar-2001	0	125	6	131
04-Apr-2001	63	243	0	306
09-Apr-2001	0	337	0	337
16-Apr-2001	0	32	0	32
23-Apr-2001	0	53	0	53
Totals	223	849	6	1,078

Table 7. Return rate of steelhead to the Root River Weir during 1994 through 2001. Number at age were estimated by expanding the proportion at each age in the aged sample against the total steelhead return.

year	number	return	Number at age								return
class	stocked	time	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total	rate
1991	39383	fall	-	-	366	267	118	29	0	779	1.98%
	71229	spring	-	-	-	1034	289	321	1	1644	2.31%
	110,612	**total**	**0**	**0**	**366**	**1301**	**406**	**349**	**1**	**2424**	**2.19%**
1992	35276	fall	0	64	117	17	62	2	0	262	0.74%
	65744	spring	-	0	852	1049	686	20	0	2607	3.96%
	101,020	**total**	**0**	**64**	**969**	**1066**	**748**	**22**	**0**	**2869**	**2.84%**
1993	30,417	fall	76	66	134	434	38	5	23	777	2.55%
	69,883	spring	-	199	1145	1290	21	0	0	2655	3.80%
	100,300	**total**	**76**	**265**	**1279**	**1724**	**60**	**5**	**23**	**3432**	**3.42%**
1994	37,347	fall	84	84	91	66	4	18		347	0.93%
	72,313	spring	-	348	673	144	165	64	2	1395	1.93%
	109,660	**total**	**84**	**432**	**764**	**210**	**169**	**82**	**2**	**1742**	**1.59%**
1995	34,254	fall	0	29	44	38	15			126	0.37%
	69,983	spring	-	31	137	999	308	24		1500	2.14%
	104,237	**total**	**0**	**60**	**181**	**1038**	**323**	**24**		**1626**	**1.56%**
1996	35,262	fall	0	0	22	102				124	0.35%
	70,225	spring	-	59	1052	1163	13			2287	3.26%
	105,487	**total**	**0**	**59**	**1074**	**1266**	**13**			**2411**	**2.29%**
1997	37,484	fall	0	0	55					55	0.15%
	66,735	spring	-	47	461	76				584	0.88%
	104,219	**total**	**0**	**47**	**517**	**76**				**640**	**0.61%**
1998	35,528	fall	0	6						6	0.02%
	53,914	spring	-	174	714					888	1.65%
	89,442	**total**	**0**	**180**	**714**					**894**	**1.00%**
1999	35,528	fall	0							0	0.00%
	54,405	spring	-	31						31	0.06%
	89,933	**total**	**0**	**31**						**31**	**0.03%**

Table 8. Estimated age composition of steelhead (sexes combined) examined at the Root River Steelhead Facility during 1994 – 2001. Age is based on age-length key developed from known-age fin clipped steelhead. Total number represents the number of steelhead used in the analysis. Fall, 2000 data are from skamania that died after transport to Kettle Moraine State Hatchery.

Year of return	Percent age composition							Total number
	1+	2+	3+	4+	5+	6+	7+	
Fall – 1994	8.9	7.5	43.2	34.2	6.2	-	-	146
Spring – 1995		7.3	31.3	38.0	12.7	10.7	-	450
Fall – 1995	15.6	12.2	21.8	49.7	0.7	-	-	147
Spring – 1996		11.0	36.1	33.1	9.1	10.1	0.6	692
Fall – 1996	-	26.3	36.8	5.3	31.6	-	-	21
Spring – 1997		1.0	22.1	42.5	22.5	10.5	1.4	483
Fall – 1997	-	4.4	14.2	67.2	9.6	4.4	-	135
Spring – 1998		15.3	35.9	37.6	5.6	5.2	0.4	287
Fall – 1998	-	-	29.3	44.0	25.3	1.4	-	75
Spring – 1999		2.1	46.5	44.2	7.3	-	-	385
Fall – 1999	-	-	32.3	54.7	5.2	7.8	-	51
Spring – 2000		8.0	21.3	53.6	14.2	3.0	-	714
Fall – 2000	-	2.7	25.3	46.7	6.7	8.0	10.7	75
Spring – 2001		3.5	83.2	8.9	1.4	2.8	0.2	482

Table 9. Average length and weight at age (± 1 standard deviation) of fin-clipped skamania from the Root River during fall, 2000. Data were only taken on fish that died prior to spawning at Kettle Moraine Springs hatchery.

Strain and sex		Age 2+	Age 3+	Age 4+	Age 5+	Age 6+	Age 7+
Skamania Female	Avg. length	26.4 (± 0 in)	27.7 (± 1.2 in)	29.5 (± 1.4 in)	28.9 (± 0.5 in)	31.2 (± 1.5 in)	30.4 (± 1.7 in)
	Avg. weight	7.0 (± 1.4 lb.)	7.4 (± 1.0 lb.)	7.9 (± 1.4 lb.)	8.3 (± 0.7 lb.)	9.7 (± 2.6 lb.)	8.9 (± 1.0 lb.)
	Obs.	2	16	27	7	2	4
Skamania Male	Avg. length		28.7 (± 0.6 in)	32.0 (± 2.1 in)	28.9 (± 0 in)	31.2 (± 1.0 in)	34.3 (± 0.4 in)
	Avg. weight		7.8 (± 0.6 lb.)	10.3 (± 2.4 in)	10.5 (± 0 in)	11.1 (± 1.5 lb.)	11.3 (± 1.7 lb.)
	Obs.	0	3	10	1	4	4

Table 10. Average length and weight at age (± 1 standard deviation) of fin-clipped steelhead examined at the Root River Steelhead Facility during spring, 2001.

Strain and sex		Age 2+	Age 3+	Age 4+	Age 5+	Age 6+
Chambers Cr. Female	Average length		23.5 (± 1.1 in)	27.5 (± 3.3 in)	31.3 (± 0 in)	27.4 (± 0 in)
	Average weight		4.7 (± 0.8 lb.)	6.9 (± 2.0 lb.)	10.7 (± 0 lb.)	7.3 (± 0 lb.)
	Observations	0	26	8	1	1
Chambers Cr. Male	Average length		24.1 (± 1.9 in)			27.9 (± 0.4 in)
	Average weight		4.7 (± 0.9 lb.)			7.0 (± 0.5 lb.)
	Observations	0	36	0	0	3
Ganaraska Female	Average length	17.1 (± 0 in)	23.6 (± 1.1 in)	26.5 (± 2.4 in)	29.3 (± 1.0 in)	29.1 (± 1.5 in)
	Average weight	1.9 (± 0 lb.)	4.7 (± 0.7 lb.)	6.7 (± 2.1 lb.)	9.0 (± 0.6 lb.)	9.1 (± 1.7 lb.)
	Observations	1	152	12	3	3
Ganaraska Male	Average length	16.9 (± 0.7 in)	23.8 (± 1.7 in)	28.2 (± 2.3 in)		28.4 (± 0 in)
	Average weight	1.6 (± 0.3 lb.)	4.6 (± 1.0 lb.)	7.7 (± 2.2 lb.)		7.3 (± 0 lb.)
	Observations	13	121	6	0	1
Skamania Female	Average length			23.0 (± 0 in)		
	Average weight			6.8 (± 0 lb.)		
	Observations	0	0	1	0	0
Skamania Male	Average length		23.7 (± 0 in)	22.1 (± 0.5 in)		
	Average weight		4.2 (± 0 lb.)	3.7 (± 0.2 lb.)		
	Observations	0	1	2	0	0

Table 11. Population estimates for chinook, coho and steelhead salmon returning to the Root River during fall, 1994 through spring, 2001. Fall steelhead are mostly skamania, but may include other strains.

Year	Species	Number of marked fish	Number of recaptured fish	Number of marked fish in recapture sample	Population size (±) 1 SD
Fall, 1994	Chinook	1,720	143	44	5,590 ± 701
	Coho	513	2	0	-
	Fall steelhead	556	22	6	1,827 ± 539
Spring, 1995	Chambers Creek	1,653	117	45	4,298 ± 503
	Ganaraska	453	74	11	2,718 ± 691
Fall, 1995	Chinook	2,663	36	21	4,478 ± 594
	Coho	1,354	33	13	3,288 ± 651
	Fall steelhead	482	36	6	2,547 ± 811
Spring, 1996	Chambers Creek	1,045	48	28	1,765 ± 206
	Ganaraska	1,457	77	31	3,551 ± 475
Fall, 1996	Chinook	5,440	37	36	5,587 ± 147
	Coho	3,940	9	9	3,940 ± 0
	Fall steelhead	105	29	0	3,150 ± 2,189
Spring, 1997	Chambers Creek	900	38	6	5,014 ± 1,606
	Ganaraska	139	23	5	5,356 ± 1,753
Fall, 1997	Chinook	3,974	40	31	5,127 ± 436
	Coho	6,909	52	45	7,983 ± 436
	Fall steelhead	228	16	2	1,297 ± 509
Spring,1998	Chambers Creek	93	15	2	501 ± 226
	Ganaraska	217	17	1	1,962 ± 1,067
Fall, 1998	Chinook	3,845	55	51	4,146 ± 156
	Coho	3,336	25	19	4,389 ± 493
	Fall steelhead	64	33	1	1,088 ± 609
	Brown	202	31	11	539 ± 118
Spring, 1999	Chambers Creek	678	-	-	-
	Ganaraska	1,043	-	-	-
Fall, 1999	Chinook	5,381	18	7	13,836 ± 4,088
	Coho	978	111	35	3,101 ± 434
	Fall steelhead	19	13	0	266 ± 181
	Brown	125	17	2	750 ± 342
Spring, 2000	Chambers Creek	460	1	0	-
	Ganaraska	1,006	21	13	1,625 ± 278
Fall, 2000	Chinook	6,965	72	13	38,575 ± 9,685
	Coho	2,921	38	11	10,091 ± 2,565
	Fall steelhead	59	16	6	157 ± 51
	Brown	241	22	1	5,302 ± 5,180
Spring, 2001	Chambers Creek	128	8	2	512 ± 313
	Ganaraska	475	27	6	2,137 ± 769

APPENDIX A. ROOT RIVER STOCKING NUMBERS

Table A-1. Number of chinook salmon stocked in the Root River during 1991 - 2000.

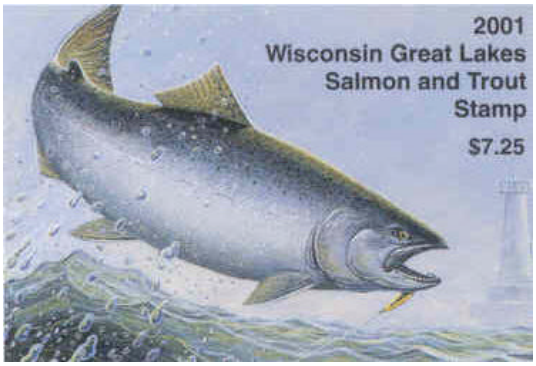
Year stocked	Total number	Strain	Fin clip
1991	174,933	Lake Michigan	None
1992	166,989	Lake Ontario	RMLV
1993	99,345	Lake Michigan	LMRV
	70,000	Lake Ontario	None
1994	75,533	Lake Michigan	LP
	60,000	Lake Michigan	None
1995	99,000	Lake Michigan	RP
	69,250	Lake Michigan	None
1996	158,000	Lake Michigan	None
1997	142,500	Lake Michigan	None
1998	161,500	Lake Michigan	None
1999	143,100	Lake Michigan	None
2000	142,900	Lake Michigan	None

Table A-2. Number of coho salmon stocked in the Root River during 1994 – 2000.

Year stocked	Total number	Strain	Fin clip	Age
1994	66,080	Lake Ontario	None	Spring yearling 1+
	55,954	Lake Ontario	RMLP	Fall fingerling 0+
	50,389	Lake Michigan	RP	Spring yearling 1+
1995	65,100	Lake Michigan	RMRP	Spring yearling 1+
	54,832	Lake Michigan	RMLV	Fall fingerling 0+
1996	40,590	Lake Michigan	RMRV	Spring yearling 1+
	63,697	Lake Michigan	LP	Fall fingerling 0+
1997	48,107	Lake Michigan	RP	Spring yearling 1+
	6,668	Lake Michigan	REL	Spring yearling 1+
	4,208	Lake Michigan	None	Spring yearling 1+
	20,604	Lake Michigan	None	Fall fingerling 0+
1998	33,666	Lake Michigan	None	Spring yearling 1+
	10,000	Lake Michigan	None	Fall fingerling 0+
1999	45,945	Lake Michigan	None	Spring yearling 1+
	13,824	Lake Michigan	None	Fall fingerling 0+
2000	41,375	Lake Michigan	None	Spring yearling 1+
	10,030	Lake Michigan	None	Fall fingerling 0+

Table A-3. Number of steelhead stocked in the Root River during 1994 – 2000.

Year stocked	Total number	Strain	Fin clip
1994	30,417	Skamania	RM
	35,124	Chambers Creek	LM
	34,759	Ganaraska	LV
1995	37,347	Skamania	ARM
	37,819	Chambers Creek	ALM
	34,494	Ganaraska	ALV
1996	34,254	Skamania	RM
	34,579	Chambers Creek	LM
	35,404	Ganaraska	ARV
1997	35,262	Skamania	RMRV
	35,024	Chambers Creek	LMLV
	35,201	Ganaraska	BV
1998	37,484	Skamania	ARM
	33,187	Chambers Creek	ALM
	33,548	Ganaraska	ALV
1999	35,528	Skamania	RM
	26,951	Chambers Creek	LM
	26,963	Ganaraska	ARV
2000	37,010	Skamania	RMRV
	27,287	Chambers Creek	LMLV
	27,118	Ganarask	BV



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